**Report on Self-Heating Working Group 2015**

Self-Heating Working Group was established during the 60th ICCP meeting in Oviedo in 2008 and the aim of the group was to establish a classification of transformed organic matter in coal (coal seam and coal heaps) and coal wastes that underwent self-heating processes. The information about establishing our working group was published in ICCP News Letter No. 45, 2008. Through all the years the Self-heating WG was active and we have carried out three Round Robin Exercises. In 2011, the material for discussion on various forms of thermally altered organic matter in coal wastes was prepared and discussed during the ICCP Meeting in Porto. It has to be reminded that during the 61st ICCP meeting in Gramado in 2009 it was decided that separate classifications have to be prepared for coal wastes dumps and coal heaps/seams.

The aim of this working group is to establish a classification of transformed organic particles in coal wastes that will reflect the conditions in the coal waste dumps. It is a very demanding task due to a number of factors, both internal (maceral composition and rank of organic matter) and external (heating history mostly heating rate, end temperature and time, access of air (the direction and strength of wind) and moisture (atmospheric precipitation)) which influence it.

In 2015 another Round Robin Exercise was prepared that was based on 30 photos and was sent as PowerPoint presentation. The reflectance of unaltered organic matter is 0.6%. Participants are asked to determine the form of organic matter in the square in accordance to the newly established classification and mark the answer in **all levels** in the attached Excel file (2015 Round Robin Exercise SHWG.xls). Two places were marked as examples. In case of unaltered particles, please mark **one** of four columns: huminite or vitrinite or liptinite or inertinite located at the back of the classification (behind the last column of the Level 6). In case of newly formed particles, please mark **one** of the following columns: bitumens, pyrolytic carbon, chars, graphite, coke located at the back of the classification (behind the last column of the Level 6). In case of altered particles, please mark **only** one of the following columns in Level 6: fractures, fissures, paler in colour oxidation rims, darker in colour oxidation rims, fractures with paler in colour oxidation rims, fractures with darker in colour oxidation rims, plasticised edges, plasticised edges with paler in colour oxidation rims, plasticised edges with darker in colour oxidation rims, bands, devolatilisation pores, devolatilisation pores with paler in colour oxidation rims, devolatilisation pores with darker in colour oxidation rims, paler in colour particle.

**Proposed classification of transformed organic particles in coal wastes**

Structure of the present classification of transformed organic matter is partially based on coal char classification in fly ashes (Suárez-Ruiz and Valentim, 2007; Suarez et al., 2007).

In the present newly established classification all organic particles are divided into six levels:

Level 1: determines the nature of the particle. Here two categories are distinguished: organic, mineral

Level 2: determines the degree of alteration of organic particles. Organic particles were divided into three types: non-altered, altered, newly formed

Level 3: determines the structure of particles. That level applies only to altered particles that are divided into: porous, massive

Level 4: determines the optical properties of particles. Both massive and porous particles were divided into two categories depending if they are: fluorescent, non-fluorescent.

Level 5: determines the texture of the particles. In this level fluorescent particles are isotropic and non-fluorescent particles might be: isotropic, anisotropic

Level 6: determines associations linked with the particle. Various categories can be distinguished among the isotropic and anisotropic particles:

for non-altered particles: huminite, vitrinite, liptinite, inertinite

for newly formed particles: bitumens, pyrolytic carbon, chars, graphite, coke

for altered particles: fractures, fissures; paler in colour oxidation rims; darker in colour oxidation rims; fractures with paler in colour oxidation rims; fractures with darker in colour oxidation rims; plasticised edges; plasticised edges with paler in colour oxidation rims; plasticised edges with darker in colour oxidation rims; bands; devolatilisation pores; devolatilisation pores with paler in colour oxidation rims; devolatilisation pores with darker in colour oxidation rims; paler in colour particle

During the exercise: levels 1 and 2 were for all particles; levels 3, 4, and 5 were for altered particles only (i.e., without non-altered and newly formed particles).

Sometimes one photo was used more than one time.

**Results of the exercise**

The results were sent by 17 participants, out of which 3 sent their answers for the first time. Some participants also sent their comments. Two participants promised to send their results in September. With regard to their work load they were not able to keep the deadline. I would like to thank all the participants for their results and comments and time spent on our working group.

The results were very good. All particles in this year exercise were organic and except of the last photo everybody determined the particles in this level properly. The problem was with next levels. In level 6 for altered particles, some participants marked more than one form while we asked to mark only one form. In future we might ask for marking more than one form if that be appropriate.

The highest level of agreement was obtained in case of particles: 2(except of 2 participants all the others stated that it is altered organic matter, paler in colour oxidation rim), 9 (except of 5 participants all the others stated that it is altered organic matter, paler in colour oxidation rim), 10 (except of 3 participants all the others stated that it is unaltered organic matter, vitrinite), 12 (except of 2 participants all the others stated that it is altered organic matter, fractures with paler in colour oxidation rim), 13 (except of 4 participants all the others stated that it is altered organic matter, paler in colour particle; in that case the problem was with isotropy/anisotropy: some participants marked that particle as anisotropic), 16 (except of 5 participants all the others stated that it is altered organic matter, plasticised edge; in that case the problem was with isotropy/anisotropy: some participants marked that particle as anisotropic), 19 (except of 1 participant all the others stated that it is pyrolytic carbon; in that case 4 participants stated that it is altered organic matter while it is newly formed organic matter), 20 (except of 4 participants all the others stated that it is altered organic matter, fractures, fissures; some participants determined this form as vitrinite; the other problem was with isotropy/anisotropy; two participants marked this form as porous), 21 (except of 3 participants all the others stated that it is altered organic matter, devolatilisation pores; some participants determined it as chars, some as newly formed particle), 22 (except of 2 participants all the others stated that it is altered organic matter, paler in colour particle), 27 (except of 4 participants all the others stated that it is altered organic matter, paler in colour particle), 28 (except of 2 participants all the others stated that it is altered organic matter, paler in colour particle), 30 (except of 4 participants all the others stated that it is newly formed organic matter, bitumens). The most troublesome forms were: 1 (unaltered organic matter, vitrinite; some participants stated it is altered organic matter, paler in colour particle), 3 (altered organic matter, paler in colour particle; 2 participants stated it is unaltered organic matter and one it is newly formed organic matter; the particle was recognized as char, coke, devolatilisation pored, inertinite; everybody agreed it is isotropic and non-fluorescent), 5 (altered organic matter, paler in colour particle, anisotropic; some participants stated it is chars, coke, some devolatilisation pores, liptinite, inertinite; the opinion if the particles is isotropic or anisotropic were very different), 6 (altered organic matter, devolatilisation pores; some participants stated it is chars, coke, plasticised edge, paler in colour particle, some huminite, vitrinite, inertinite; some stated it is unaltered organic matter or newly formed organic matter), 7(altered organic matter, paler in colour particle; some participants stated it is chars, coke, devolatilisation pored, some vitrinite, inertinite; some stated it is unaltered organic matter or newly formed organic matter), 8 (altered organic particles, plasticised edge; some participants stated it is unaltered particle, vitrinite, inertinite, bitumens, paler in colour particle), 11 (altered organic matter, fractures and fissures also paler in colour particle; many participant marked both forms here; others determined it as devolatilisation pores, paler in colour oxidation rims; vitrinite; there was opinion that it is unaltered organic matter or newly formed organic matter), 14 (altered organic matter, paler in colour oxidation rim, paler in colour particle), 15 (altered organic matter, fractures, fissures; the form was also recognised as newly formed, porous, anisotropic, vitrinite, inertinite, chars, paler in colour oxidation rims, fractures with paler or darker oxidation rims, paler in colour particle), 17 (altered organic matter, devolatilisation pores; the form was also recognised as non-altered, newly formed, porous, inertinite, chars, coke, paler in colour particle; the opinion on isotropy/anisotropy were very different), 18 (altered organic matter, paler in colour particle; the form was also recognised as newly formed, inertinite, chars, coke, devolatilisation pores), 23 (altered organic matter, band; the form was also recognised as vitrinite, bitumens, paler in colour oxidation rims, darker in colour oxidation rims, plasticised edges with paler in colour oxidation rims, paler in colour particle), 24 (altered organic matter, plasticised edge with paler in colour oxidation rim; the form was also recognised as vitrinite, paler in colour oxidation rim, devolatilisation pore with paler in colour oxidation rim, plasticised edge with darker in colour oxidation rim, paler in colour particle), 25 (altered organic matter, plasticised edge; the form was also recognised as vitrinite, fractures, fissures, paler in colour oxidation rims, plasticised edge with paler in colour oxidation rim, devolatilisation pore with paler in colour oxidation rim, paler in colour particle), 26 (altered organic matter, devolatilisation pore with paler in colour oxidation rims; the form was also recognised as paler in colour particle, devolatilisation pore, fractures with paler in colour oxidation rims, fractures, fissures, paler in colour oxidation rims, vitrinite).

Comments from participants

Comments from Ivana:

I think that would be a good idea to define exactly what we classify: if the particles used in the first column, LEVEL 1 and also in DESCRIPTION or structure of an organic or carbonaceous material on the defined area or at the point, which is determined in analysis.

1. What is the boundary between the types of "altered organic matter" and "char / coke" (the newly formed organic matter) in the case of un-caking or weakly caking coals.

V případě „alterovaných částic? In the case of "altered particles? organické-uhlíkaté hmoty“ navrhuji rozlišit: Organic-carbonaceous mass "I propose to distinguish:

i) **slabou alteraci** macerálů (vitrinitu, liptinitu a inertinitu)se změněnými optickými vlastnostmi a se zachovalou texturou a morfologií; i) **weak alteration** **macerals** (vitrinite, liptinite and inertinite) with altered optical properties and is preserved texture and morphology;

ii) silnou alterací macerálů se změněnými optickými vlastnostmi a s do určité míry ještě rozlišitelnou morfologii macerálů a dalších struktur po jejich odplynění se změněnými optickými vlastnostmi, zvýšenou odrazností. ii) **strong alteration macerals** with altered optical properties and to some extent still distinguishable morphology macerals and other structures after degassing with modified optical properties, improved reflectivity.

1. V klasifikaci 3.typu alterované organické (uhlíkaté hmoty) se domnívám , že by bylo možné změnit typy “Nově vzniklých částic – organické-uhlíkaté hmoty“ podle podílu produktů při alterace: The classification 3.Types altered organic (carbon material), I think it would be possible to change the types of "newly created particles - Organic-carbon materials," according to the proportion of products in the alteration:
   1. char char
   2. coke coke
   3. bitumens Bitumens
   4. pyrolytic carbon pyrolytic carbon
   5. graphite graphite
2. Skupina bitumenů v navržené klasifikaci obsahuje pouze uhlovodíky se žlutou fluorescencí dle (Alpern et al. 1992). Bitumens in the proposed classification includes only hydrocarbons by yellow fluorescence (Alpern et al. 1992). Při studium vzorků ze samovznícených uhelných slojí a hald v intrasudetské a hornoslezské pánvi, ale i v hnědouhelných ložiscích jsem identifikovala masivní útvary dehtovité povahy. When studying samples from self-heating processes in coal seams and in coal wastes in the Intrasudetic Basin, and in the Upper Silesian Basin, but also in lignite deposits I identified a massive formations of pitchy - tarry nature. (Fotografii pošlu později). (Microphotos i shall send it later). Při klasifikaci bitumenů by bylo vhodné zařadit bitumeny se zvýšenou odrazností a bez fluorescence dle klasifikace H.Jacob (1993) [ *H.Jacob : Nomenclature , Classification , Characterization* When classifying bitumen would be appropriate to include bitumen with increased reflectivity and no fluorescence according to the classification H.Jacob (1993) *[H.Jacob: Nomenclature, Classification, Characterization* *and* *and* *Genezis* *Genezis* *of* *of* *Natural Solid Bitumen ( Migrabitumen ).* *Natural Solid Bitumen (Migrabitumen).* *In: J.Parnel , H. Kucha , P. Landais , 1993. Bitumens in Ore* *In: J.Parnel, H. Kucha, P. Landais, 1993. Bitumens in Ore* *Deposits . Special* *Deposits. Special* *Publication No.9 of* *Publication of No.9* *the Society for Geology Applied to Mineral Geology, Springer - Verlag , Berlin, Heidelberg, … , 11-27* .] *the Society for Geology Applied to Mineral Geology, Springer - Verlag, Berlin, Heidelberg, ..., 11 to 27]*
3. Řadí se mezi formy optické anizotropie take undulózní zhášení nebo plošná anizotropie? Ranks among the forms of optical anisotropy also undulose extinction or surface anisotropy?
4. Hodnocení plastických lemů se mi zdá subjektivní, zvláště, pokud se nehodnotí částice jako celek. Rating plastic rims seems subjective, especially if the particles are not assessed as a whole. I am sorry for my English.

Comments from Kimon,

* At level 3 (massive/porous): on some photos it was a little bit confusing to me (e.g. see photo 4; on my table yellow highlighted). This is also a problem for photo 30. Maybe we have to replace ‘porous’ with ‘non-massive’ in order to comprise fractures and dispersed material too.
* I faced a similar problem at the edges of particles (e.g. photos 8, 25; the particle is massive, the cross is projected on the particle but half of the square is on the pore).
* In photo 11 I could not recognise if there are liptinite macerals (cutinite) or fissures.
* In photo 30 I crossed both organic particles and minerals; this is of course, the lonely case of double-crossing at the same level.

Comments from Jen:I do not like choosing only one qualifier from category 6 – there were a few cases where you had one major feature with a minor feature (brighter than usual particle or devolatilization holes) also occurring.

Comment from Ashok: It is too exhaustive for any regular analyst and should be shortened in final phase.